CASSINI'S ION AND NEUTRAL MASS SPECTROMETER OBSERVES CARBON-RICH GRAINS IN SATURN'S EXOSPHERE.

K. E. Miller[1], J. H. Waite, Jr.[1], R. Perryman[1], C. R. Glein[1], and M. Perry[2], [1]Southwest Research Institute, San Antonio, TX, USA, 78238 [2]Johns Hopkins Applied Physics Laboratory, Laurel, MD, USA, 20723. Correspondence to kmiller@swri.edu.

Introduction: During Cassini's Grand Finale, the Ion and Neutral Mass Spectrometer (INMS) collected compositional data from Saturn's exosphere. Throughout the mission, INMS has measured the composition of the Saturnian system, producing mass spectra with unit-mass resolution from 1u to 99u from various bodies, including Titan and Enceladus. The final six Cassini orbits skimmed through altitudes within 2,000 km of Saturn's 1-bar pressure level, providing an unprecedented chemistry dataset. Earlier models suggested that the only neutrals present above INMS detection limits would be H_2, HD, and He [1, 2]. Instead, INMS measured signal across its full mass range, including organic species. Based on their altitude profiles, masses greater than 4u originate from Saturn's rings, most likely as nanoparticles. Our presentation will focus on the C-bearing and volatile components of these ring particles, including compositional fitting of the mass spectra.

Methods: Mass spectra were fit using a combination of INMS calibration data and NIST ionization-dissociation patterns. Our fitting routine follows [3] using a catalog of species compiled based on observations of comets [4, 5] and ice irradiation experiments [6, 7]. Species selected from the catalog are fit according to their most abundant peak, which is frequently the M^+ peak. Using a linear combination of peak fragments, a residual mass spectrum is calculated subsequent to the addition of each species. As such, the fits are degenerate and are dependent on the order in which compounds are added. To account for this, we generate multiple independent fits for each spectrum to constrain the range of possible compositions.

Results: The mass spectra indicate abundant C-bearing material in Saturn's exosphere. CH_4 and other organics are major contributors to masses above 4u. CO_2 is likely present, although its identification is complicated by the presence of isobaric C_3H_8. Signal at 28u is partially attributed to C_2H_4, but also appears to have contributions from CO or N_2.

Masses below ~70u are fit well by a combination of hydrocarbons, water, ammonia, H_2, HD, CO_2, CO or N_2, He, and low abundances of S-bearing species such as H_2S. These masses do not require the presence of N-bearing or O-bearing organics. However, at present the fit also does not exclude the possibility of these species. Above 70u, mass spectra are consistent with fragments from large aromatic species, although unambiguous identification of the parent molecules is not possible.

Discussion: Our current fits for organics (excluding methane) yield bulk H/C ratios between 2 and 2.5, and O/C and N/C ratios less than 0.2. Most N is attributed to NH_3, which may be either an indigenous species or a product of high-velocity impacts of organic nanoparticles with the spacecraft. Ongoing work is focused on constraining elemental ratios and comparing to chondritic IOM [8] and organics associated with cometary dust [9].

References: [1] Müller-Wodarg I. *et al.*, (2012) *Icarus, 221*, 481-494. [2] Koskinen T. *et al.*, (2015) *Icarus, 260*, 174-189. [3] Magee B. A. *et al.*, (2009) *Planetary and Space Science, 57*, 1895-1916. [4] Bockelée-Morvan D., (2011) *Proceedings of the International Astronomical Union, 7*, 261-274. [5] Altwegg K. *et al.*, (2017) *Monthly Notices of the Royal Astronomical Society,* S130-S141. [6] Materese C. K. *et al.*, (2015) *The Astrophysical Journal, 812*, 150. [7] Hudson R. *et al.* (University of Arizona Press, Tucson, 2008), pp. 507-523. [8] Alexander C. O. D. *et al.*, (2007) *Geochimica et Cosmochimica Acta, 71*, 4380-4403. [9] Bardyn A. *et al.*, (2017) *Monthly Notices of the Royal Astronomical Society, 469*, S712-S722.